THE MODULATOR

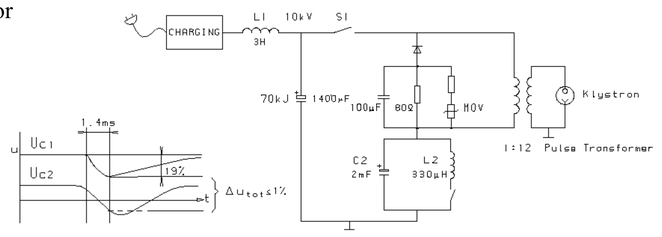
Modulator Requirements

	Typical	Maximum
Klystron Gun Voltage	115kV	120kV
Klystron Gun Current	130A	140A
High Voltage Pulse Duration (70% to 70%)	<1.7ms	1.7ms
High Voltage Rise and Fall Time (0 to 99%)	<0.2ms	0.2ms
High Voltage Flat Top (99% to 99%)	1.37ms	1.5ms
Pulse Flatness during Flat Top	< ±0.5%	±0.5%
Pulse-to-Pulse Voltage fluctuation	< ±0.5%	±0.5%
Energy Deposit in Klystron in Case of Gun Spark	<20J	20J
Pulse Repetition Rate for 90% of the Modulators	5Hz	5Hz
Pulse Repetition Rate for 10% of the Modulators	10Hz	10Hz
Transformer Ratio	1:12	1:12
Filament Voltage	9V	11V
Filament Current	50A	60A

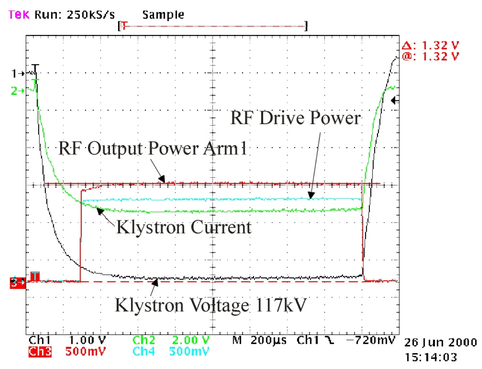
The Fermilab Type Bouncer Modulator

One of the Fermilab Type Bouncer Modulators at TTF

The first Modulator is in operation since 1994



Bouncer Modulator Circuit Diagram (schematic)

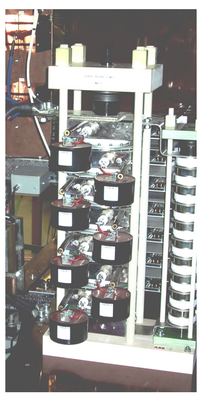


Waveforms at the Fermilab type Bouncer Modulator with a Multibeam Klystron installed

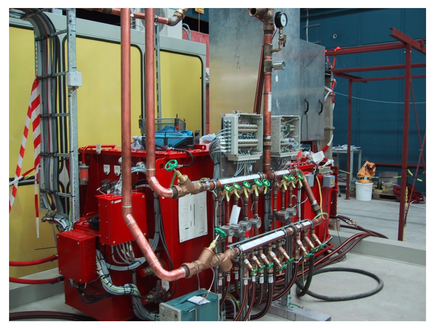
The Next Generation Bouncer Modulator

Features:
- Constant Power High Voltage Power Supply
- Integrated Gate Commutated Thyristor (IGCT) Switch instead of IGBT or GTO Technology
- Lower Leakage Inductance Pulse Transformer
- Partially Industry manufactured

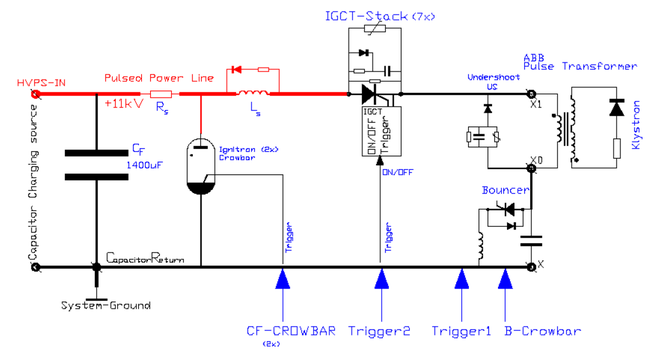
HVPS Capacitor Bank Bouncer



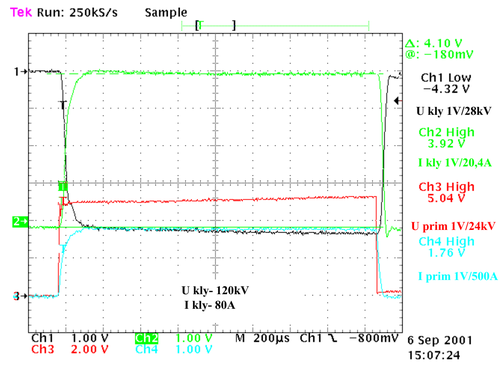
The IGCT Stack



The Pulse Transformer

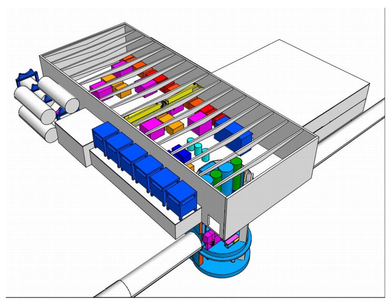


Modulator Circuit

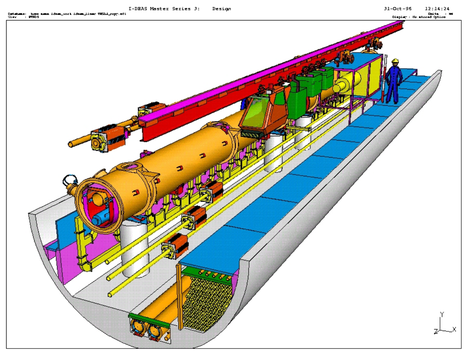


Waveforms at the Next Generation Bouncer Modulator with a 5MW Klystron installed

Installation



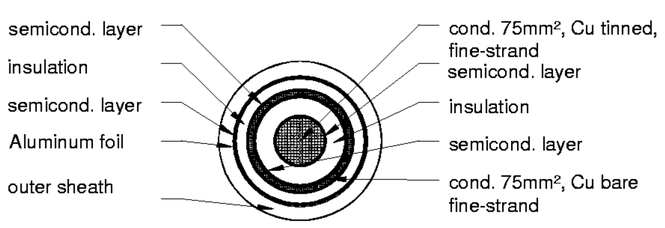
Modulator Hall and Kryo Hall



Pulse Transformer and Klystron in the Tunnel

Power Requirements and Efficiency

RF peak power per RF station	9.7MW
Duty cycle	0.685%
Average RF power available per RF station	66kW
Klystron efficiency	65%
Modulator efficiency	85%
Total efficiency	55%
AC power per RF station	120kW
Auxiliary power per RF station incl. LLRF and waveguide tuner	14kW
Total wall plug power per station	134kW
Number of active stations	560
Total wall plug power	75MW



The High Voltage Pulse Cable